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SCROLL COMPRESSOR
[SUKUROORU ASSHUKUKI]

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[Claim(s)]

[Claim 1] A scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through said orbiting scroll and said fixed scrolls for orbiting without rotating said orbiting scroll with respect to said fixed scrolls so that a gas is compressed, wherein said scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, a first oil supply passage which is linked to said lubricating oil sump, a second oil supply passage which is linked to said first and is formed to orbit eccentrically with respect to said first oil supply passage, and a bearing feed hole which is linked to said second oil supply passage and is formed radially outward.

[Claim 2] A scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, a crank shaft provided through said orbiting scroll and said fixed scrolls for orbiting said orbiting scroll with respect to said fixed scrolls so that a gas is compressed, wherein said scroll compressor further

comprises a lubricating oil sump which has a high-pressure atmosphere, an oil supply passage which is linked to said lubricating oil sump, a bearing feed hole which is linked to said oil supply passage and is formed radially outward, and a forced pumping means which is arranged at the lubricating oil sump end of said bearing feed hole.

[Claim 3] A scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, a frame which supports the fixed scroll movably in a longitudinal direction of a crank shaft, an operating chamber that is configured of said frame, said fixed scrolls and a cylinder, a linking passage which links said operating chamber and a compression chamber which is formed of said orbiting scroll and said fixed scrolls wraps, and a crank shaft provided through said orbiting scroll and said fixed scrolls for orbiting said orbiting scroll with respect to said fixed scrolls so that a gas is compressed, wherein said scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, a first oil supply passage which is linked to said lubricating oil sump, a second oil supply passage which is linked to said first and is formed to orbit eccentrically with respect to said first oil supply

passage, and a bearing feed hole linked to said second oil supply passage which is formed radially outward.

[Claim 4] A scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through said orbiting scroll and said fixed scrolls for orbiting without rotating said orbiting scroll with respect to said fixed scrolls so that a gas is compressed, wherein said scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, a first oil supply passage which is linked to said lubricating oil sump, a second oil supply passage which is linked to said first and is formed to orbit eccentrically with respect to said first oil supply passage, and a bearing feed hole linked to said second oil supply passage which is formed radially outward.

[Claim 5] A scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through said orbiting scroll and said fixed scrolls for orbiting without rotating said orbiting scroll with respect to said fixed scrolls so that a gas is compressed, wherein said scroll compressor further comprises a lubricating oil sump

which has a high-pressure atmosphere, an oil supply passage which is linked to said lubricating oil sump, a bearing feed hole which is linked to said second oil supply passage and is formed radially outward, and a forced pumping means which is arranged at the lubricating oil sump end of said bearing feed hole.

[Claim 6] A scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through said orbiting scroll and said fixed scrolls for orbiting without rotating said orbiting scroll with respect to said fixed scrolls as a result of a rotation prevention mechanism so that a gas is compressed, wherein said scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, an oil supply passage which is linked to said lubricating oil sump, a bearing feed hole which is linked to said second oil supply passage and is formed radially outward, and an oil supply passage which links said bearing feed hole to said rotation prevention mechanism.

[Claim 7] The scroll compressor according to any one of claims 4 to 6 that is characterized in that a sealing mechanism is disposed between said orbiting scroll and said

fixed scrolls and an oil return passage is linked to said lubricating oil sump.

[Claim 8] The scroll compressor according to claim 7 that is characterized in that a gas compressed by both wraps of said orbiting scroll and said fixed scrolls is directly to the exterior the exterior of the compressor.

[Claim 9] The scroll compressor according to claim 7 that is characterized in that said lubricating oil sump portion of said crank shaft is formed as a low-pressure atmosphere by both walls on opposing ends.

[Detailed Description of the Invention]

[0001]

[Industrial Application] The present invention relates to a scroll compressor used in refrigerated air conditioners, air compressors, and such. More particularly, it relates to a scroll compressor which includes a double meshing orbiting scroll and a crank shaft for rotating the orbiting scroll extended through the orbiting scroll and fixed scrolls.

[0002]

[Description of the Prior Art] Such a conventional scroll compressor is disclosed in Japanese Patent Unexamined Publication No. 05-187372, that is, it includes an orbiting scroll having involute wraps on both sides in the

longitudinal direction, a pair of fixed scrolls having an involute wrap fitted to the wrap of the aforementioned orbiting scroll, and a main shaft provided through the aforementioned orbiting scroll and the aforementioned fixed

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scrolls for orbiting the aforementioned orbiting scroll.

[0003]

[Problem(s) to be Solved by the Invention] However, since the aforementioned conventional technology discloses a scroll fluid machinery that is not supplied with oil, it does not disclose a lubrication mechanism and means for this compressor.

[0004] An object of the present invention relates to an oil supply method for a scroll compressor which is configured with a double meshing orbital scroll and a crank shaft that extended through the aforementioned orbital scroll and fixed scrolls and to provide a scroll compressor with good reliability

[0005]

[Means for Solving the Problem] To attain the aforementioned object, the scroll compressor according to the present invention comprises an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface

to face, and a crank shaft provided through the aforementioned orbiting scroll and the aforementioned fixed scrolls for orbiting without rotating the aforementioned orbiting scroll with respect to the aforementioned fixed scrolls so that a gas is compressed, wherein the aforementioned scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, a first oil supply passage which is linked to the aforementioned lubricating oil sump, a second oil supply passage which is linked to the aforementioned first and is formed to orbit eccentrically with respect to the aforementioned first oil supply passage, and a bearing feed hole which is linked to the aforementioned second oil supply passage and is formed radially outward.

[0006] Further, it is a scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, a crank shaft provided through the aforementioned orbiting scroll and the aforementioned fixed scrolls for orbiting the aforementioned orbiting scroll with respect to the aforementioned fixed scrolls so that a gas is compressed, wherein the aforementioned scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, an oil supply passage which

is linked to the aforementioned lubricating oil sump, a bearing feed hole which is linked to the aforementioned oil supply passage and is formed radially outward, and a forced pumping means which is arranged at the lubricating oil sump end of the aforementioned bearing feed hole.

[0007] Moreover, it is a scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, a frame which supports the fixed scroll movably in a longitudinal direction of a crank shaft, an operating chamber that is configured of the aforementioned frame, the aforementioned fixed scrolls and a cylinder, a linking passage which links the aforementioned operating chamber and a compression chamber which is formed of the aforementioned orbiting scroll and the aforementioned fixed scrolls wraps, and a crank shaft provided through the aforementioned orbiting scroll and the aforementioned fixed scrolls for orbiting the aforementioned orbiting scroll with respect to the aforementioned fixed scrolls so that a gas is compressed, wherein the aforementioned scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, a first oil supply passage which is linked to the aforementioned lubricating oil sump, a second oil

supply passage which is linked to the aforementioned first and is formed to orbit eccentrically with respect to the aforementioned first oil supply passage, and a bearing feed hole linked to the aforementioned second oil supply passage which is formed radially outward.

[0008] Furthermore, it is a scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through the aforementioned orbiting scroll and the aforementioned fixed scrolls for orbiting without rotating the aforementioned orbiting scroll with respect to the aforementioned fixed scrolls so that a gas is compressed, wherein the aforementioned scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, a first oil supply passage which is linked to the aforementioned lubricating oil sump, a second oil supply passage which is linked to the aforementioned first and is formed to orbit eccentrically with respect to the aforementioned first oil supply passage, and a bearing feed hole linked to the aforementioned second oil supply passage which is formed radially outward.

[0009] Further, it is a scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat

plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through the aforementioned orbiting scroll and the aforementioned fixed scrolls for orbiting without rotating the aforementioned orbiting scroll with respect to the aforementioned fixed scrolls so that a gas is compressed, wherein the aforementioned scroll compressor further comprises a lubricating oil sump which has a high-pressure atmosphere, an oil supply passage which is linked to the aforementioned lubricating oil sump, a bearing feed hole which is linked to the aforementioned second oil supply passage and is formed radially outward, and a forced pumping means which is arranged at the lubricating oil sump end of the aforementioned bearing feed hole.

[0010] Moreover, it is a scroll compressor comprising an orbiting scroll having volute wraps on both sides of a flat plate eccentrically assembled with fixed scrolls having a wrap paired surface to face, and a crank shaft provided through the aforementioned orbiting scroll and the aforementioned fixed scrolls for orbiting without rotating the aforementioned orbiting scroll with respect to the aforementioned fixed scrolls as a result of a rotation prevention mechanism so that a gas is compressed, wherein the aforementioned scroll compressor further comprises a

lubricating oil sump which has a high-pressure atmosphere, an oil supply passage which is linked to the aforementioned lubricating oil sump, a bearing feed hole which is linked to the aforementioned second oil supply passage and is formed radially outward, and an oil supply passage which links the aforementioned bearing feed hole to the aforementioned rotation prevention mechanism.

[0011]

[Function] According to the present invention, whether a lubricating oil sump has a high-pressure or a low-pressure atmosphere, lubrication of each part of a bearing or a sliding member can be performed certainly with a configuration wherein a second oil supply passage which is formed eccentrically such that it links to an oil supply passage which links to the aforementioned lubricating oil sump is provided and a bearing oil feed hole is formed radially outward such that it links to the aforementioned second oil supply passage or a configuration wherein a forced pumping means or a volute passage which links to the aforementioned bearing oil supply hole which is formed radially outward is arranged in the end of the aforementioned lubricating oil sump of the aforementioned oil supply passage.

[0012] Moreover, when a lubricating oil sump has a low-pressure atmosphere, lubrication to each part of a bearing or a sliding member can be further performed certainly by a configuration wherein a seal mechanism is provided between the aforementioned orbiting scroll and the aforementioned fixed scrolls such that the oil return passage is linked to the aforementioned lubricating oil sump.

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[0013]

[Embodiments] Hereafter, some embodiments of the present invention are explained with reference to the drawings.

[0014] Figure 1 shows the overall structure of the scroll compressor according to this embodiment. Figure 2 shows a perspective view of an Oldham's coupling 15, and Fig. 3 and Fig. 4 show the sectional views of a orbiting scroll 6 and a second fixed scroll 5. The scroll compressor shown in Fig. 1 comprises a tightly sealed container 1 of cylindrical shape with the top and bottom ends sealed and its axis being substantially vertical to the ground, a first frame 2 and a second frame 3 fixed in an upper portion of the tightly sealed container 1 with their axes aligned with that of the tightly sealed container 1, a first fixed scroll 4 and second fixed scroll 5 slidably mounted inside the first frame 2 and the second frame 3 with their axes

aligned with those of the first frame and the second frame, each fixed scroll having a volute wrap on one side so that the upper and lower wraps are opposite to each other, an orbiting scroll 6 having wraps opposing and rotatably mounted between the fixed scrolls 4, 5, an orbiting scroll driving motor, composed of a stator 7a and a rotor 7b, provided below the second frame 3 with its axis aligned with those of the first and second fixed scrolls 4, 5, a crank shaft 8 coupled with the rotor 7b and rotated by the rotor 7b such that the orbiting scroll 6 can be rotated by the crank shaft 8 through a swing bearing 6b, a suction pipe 9 provided through the side wall of the tightly sealed container 1 for supplying a space with a gas to be compressed, the space formed by the wrap of the first fixed scroll 4 and the wrap of the orbiting scroll 6, and a discharge pipe 10 provided through the side wall of the tightly sealed container 1.

[0015] The crank shaft 8 is constituted of a part 8d coupled with the rotor 7b, a lower supporting shaft portion 8b extending upwardly from the top of the part 8d and held by a second frame bearing 3a in the center of the second frame 3, an eccentric shaft portion 8a extending upwardly from the top of the lower supporting shaft portion 8b and fitted into the swing bearing 6b, an upper supporting shaft

portion 8c extending upwardly from the top of the eccentric shaft portion 8a and held by a first frame bearing 2a fixed at the center of the first frame 2, a lower-end supporting shaft portion 8e extending downwardly from the bottom of the part 8d and held by an auxiliary bearing 12 fixed in an auxiliary frame 11 fixed on the side wall of the tightly sealed container 1, and an oil pump 8f opening into the base of the tightly sealed container 1. The crank shaft 8 further includes a lower balance weight 13 and an upper balance weight 14 mounted around the lower supporting shaft portion 8b and the upper supporting shaft portion 8c, respectively, so that centrifugal force of the orbiting scroll 6 and the moment by the centrifugal force are canceled, thereby preventing vibrations. It should be noted that the second frame bearing 3a is provided with a collar for supporting the total weight of the crank shaft 8 and the rotor 7b. The orbiting scroll 6 is prevented by an Oldham's coupling 15 from turning on its axis (rotation centering the eccentric shaft portion 8a), so that the rotation of the eccentric shaft portion 8a provides an eccentric (orbiting) motion to the orbiting scroll 6. As shown in Fig. 2, the Oldham's coupling 15 is formed in a ring or elliptical ring shape with two ring portions 15a, 15b and six keys 15c, 15d, 15e, 15f, 15g and 15h. That is,

the Oldham's coupling 15 has a split construction from the center of the width of the key pairs 15c, 15h and 15e, 15f. The keys 15c, 15h and 15e and 15f of the Oldham's coupling 15 slide in key grooves 6c, 6d formed in the orbiting scroll 6, respectively, as shown in Fig. 3, and key grooves 5b, 5c formed in the second fixed scroll 5, respectively, as shown in Fig. 4. The ring portions 15a, 15b of the Oldham's coupling 15 are accommodated in a concave groove portion 6e in the center of the panel of the orbiting scroll 6.

[0016] Figure 3 and Figure 4 show sectional views of the orbiting scroll 6 and the second fixed scroll 5, respectively. The first turn of the wrap 6a of the orbiting scroll 6, is formed into an arc whereas the last turn comes close to or coincides to the outer edge of a panel 6f. A discharge passage 6g (6i) and a discharge through-hole 6h are provided at an outer portion of the panel 6f. The discharge passage 6g are formed axially on the opposite sides of the orbiting scroll 6 (on the upper and lower sides in Fig. 1) and are in communication with each other by the discharge through-hole 6h. In the second fixed scroll 5, the first turn and the last turn of the wrap 5a are formed into arcs and an insertion hole 5d is provided inwardly nearby the first turn of the wrap 5a. On the other

hand, a suction passage 5e is provided outwardly nearby the last turn of the wrap 5a.

[0017] Figure 5 shows a sectional view of the first fixed scroll 4. In the first fixed scroll 4, an inlet 4b is provided nearby the last turn of the wrap 4a for communicating the suction pipe 9 provided through the side wall of the tightly sealed container 1, whereas a discharge through-hole 4c is provided nearby the first turn of the wrap 4a to be open to the discharge passage 6g axially formed at one end of the orbiting scroll 6 (on the upper end surface in Fig. 1). The discharge through-hole 4c is in communication with a discharge space 1a in the upper portion of the tightly sealed container 1 by a discharge passage 2c provided through the first frame 2.

[0018] The wrap 6a of the orbiting scroll 6, the wrap 4a of the first fixed scroll 4, and the wrap 5a of the second fixed scroll 5 form a compression chamber 16 that communicates with the discharge passages 6g, and a compression chamber 17 that communicates with the discharge passage 6i, respectively.

[0019] A ring shape convex part 4e with a seal ring 4d is formed in the side part of the first frame 2 of the first fixed scroll 4 and the ring shape convex part 4e is fitted

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into the aforementioned ring shape recessed part 2b formed in the first frame 2 via the aforementioned seal ring 4d, to form and operating chamber 18. On the other hand, a ring shaped recessed part 5f is fitted into the side part of the aforementioned second frame 3 of the aforementioned second fixed scroll 5. The ring shape convex part 3c which was formed in the second frame 3 and was provided with the seal ring 3b is fitted into the aforementioned ring shaped recessed part 5f via the seal ring 3b, forming an operating chamber 19. The aforementioned operating chambers 18 and 19 are connected with the aforementioned compression spaces 16, 17 by communicating holes 4f, 5g which have been opened in the first fixed scroll 4 and the second fixed scroll 5. The pressure in the operating chambers 18 and 19, excluding the discharge pressure, can be optionally set here. That is, by having a configuration which provides an intermediate pressure or suction pressure and releases the first fixed scroll or the second fixed scroll to the axial direction of the orbiting scroll, a compressor can be operated while always maintaining a proper space between the tip of the wrap of the orbiting scroll and the tip of the wrap of the fixed scrolls, and when a phenomena, such as liquid compression or an abnormal rise in the internal pressure of the compression space, occurs, abnormal loads on the

sliding contact surface of the end outside the boundary plate of the orbiting scroll and the end outside the boundary plate of the fixed scrolls can be avoided by releasing the fixed scrolls from the orbiting scroll.

[0020] In the compressor with the aforementioned composition, when the orbiting scroll 6 rotates eccentrically (orbits) by the rotation of the crank shaft 8, the fluid to be compressed is sucked in from the suction pipe 9 and is compressed by the compression spaces 16, 17, and after a predetermined pressure (discharge pressure) is reached and it is discharged by the discharge space 1a of the upper part of the aforementioned tightly sealed container 1 from the discharge passages 6g, 6i, the discharge hole 6h, the through hole 4c, and the discharge passage 2c, it is discharged out of the tightly sealed container 1 through the discharge tube 10.

[0021] Next, the lubrication structure of this embodiment is explained.

[0022] The first oil supply passage 23 that links to the lubricating oil sump 22 which is under a high-pressure (discharge pressure) atmosphere stored in the base of the aforementioned tightly sealed container 1 is formed in the aforementioned feed pipe 8f provided in the lower end of the aforementioned crank shaft 8. This is linked to the

first oil supply passage 23, and the second oil supply passage 24 formed eccentrically with respect to the axial center of the first oil supply passage 23, i.e., a crank shaft, is extended to the upper supporting shaft which is an upper support shaft of the crank shaft 8. A bearing feed hole formed radially outward such that it is linked to each bearing is installed in the aforementioned second oil supply passage 24. That is, the second frame bearing feed hole 25 is linked to the second frame bearing 3a, the orbital bearing feed hole 26 is linked to the orbital bearing 6b, and the first frame bearing feed hole 27 is linked to the first frame bearing 2a, respectively. In the second oil supply passage 24, a sufficient passage area is secured so that pressure loss does not occur. The first oil supply passage 23 and the second oil supply passage 24 are formed by linking radial holes drilled axially at center and eccentric positions of the crank shaft, respectively, and holes drilled radially in the crank shaft at the upper part of the former and the lower part of the latter, and closing them with sealing plugs at the ends of the holes. Other oil supply passages are formed similarly.

[0023] The oil in the lubricating oil sump 22 that has been sucked through the first oil supply passage 23 and the second oil supply passage 24 by a centrifugal pumping

action is supplied via the second frame bearing feed hole 25 to second frame bearing 3a, via the orbital bearing feed hole 26 to the orbital bearing 6b, and via the first bearing feed hole 27 to the first frame bearing 2a, respectively. Here, a portion of the oil which lubricated the second frame bearing 3a passes through the bearing spaces to an electric motor chamber 28, and the remaining oil flows into the aforementioned electric motor chamber 28 via the oil return hole 29 formed in the second fixed scroll 5 and the upper part of the second frame. Part of the oil which lubricated the orbital bearing 6b flows downward through the bearing spaces and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining oil which lubricated the first fixed frame shaft carrier 2a flows toward the upper part to the aforementioned discharge passage 6g through the bearing spaces. Further, part of the oil which lubricated the first fixed frame bearing 2a flows downward through the bearing spaces to the and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining oil which lubricated the first fixed frame shaft carrier 2a flows toward the upper part to the aforementioned discharge passage 6g through the bearing spaces to the aforementioned

discharge passage 6g, and the remaining oil goes upward through the bearing spaces to the discharge space 1a. The oil discharged by the aforementioned discharge space 1a flows through the oil return path 30 in which the fluid to be compressed flows and which is provided in the peripheral part of the first frame and the second frame, is recirculated to the electric motor chamber 28, and together with the oil recirculated to the electric motor chamber 28 via the aforementioned hole 29, returns to the lubricating oil sump 22 under gravity.

[0024] Below, another embodiment of the present invention is described. Figure 6 shows the overall structure of a scroll compressor according to another embodiment of the present invention. Portions common to those of the first embodiment in Fig. 1 are given the same reference numbers and the descriptions thereof are omitted. A feature of this embodiment is a forced pumping means installed in the lower end of the aforementioned crank shaft 8 compared with the embodiment shown in Fig. 1. That is, a trochoid pump, a gear pump, etc., is installed in the lower end supporting shaft 8e end of the crank shaft 8 as a forced pumping means, which comprises a pump shaft 31 which is formed in the aforementioned lower end supporting shaft 8e end, an inner rotor 32 which is directly linked to the pump shaft 31, an

outer rotor 33 which meshes with and drives the inner rotor 32, an upper side plate 35 and a lower side plate 36 which configure the upper and lower sides of a casing 34 which accommodates an outer rotor 33, and the casing 34 is fixed to the aforementioned auxiliary frame 11. In the aforementioned lower side plate 36, an outlet 38 is established that is linked with the suction hole 37 which is open to the oil in the aforementioned lubricating oil sump 22, and the entrance of the lower part of the oil supply passage 23 formed in the center section of the crank shaft 8. The oil supply passage 23 is extended to the upper supporting shaft which is an upper support shaft of the crank shaft 8, and a second frame bearing feed hole 25, a orbital bearing feed hole 26, and a first frame bearing feed hole 27 are installed and formed radially outward such that they link to each bearing.

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[0025] In this type of configuration, when the pump shaft 31 is driven by the rotation of the crank shaft 8, it engages the inner rotor 32 and the outer rotor 33. The oil in the lubricating oil sump 22 is sucked out from the suction hole 37, the pressurized oil is sent to the outlet hole 38, and lubricating oil is fed from each bearing feed hole through the oil supply passage 23 at each bearing. The

path which carries out lubrication of each bearing and returns oil to the lubricating oil sump 22 is the same as in the aforementioned embodiment.

[0026] Below, another embodiment of the present invention is described. Figure 7 shows the overall structure of a scroll compressor which is another embodiment of the present invention. Portions common to those of the first embodiment in Fig. 1 are given the same reference numbers and the descriptions thereof are omitted. Here, The oil supply passage 23 is formed in the center section of the aforementioned crank shaft 8, and the aforementioned feed pipe 8f of the lower part of the crank shaft 8 opens to the lubricating oil sump 22 under a high-pressure atmosphere in the base of the aforementioned tightly sealed container 1. The oil supply passage 23 is extended to the upper supporting shaft which is the upper support shaft of the crank shaft 8, and the second frame bearing feed hole 25, the orbital bearing feed hole 26, and the first frame bearing feed hole 27 which are formed radially outward such that they link to each bearing are installed, respectively. Volute slots 39, 40, and 41 are formed in the peripheral part of the shaft, respectively, such that they are linked to the second frame bearing feed hole 25, the orbital bearing feed hole 26, and the first frame bearing feed hole

27. The aforementioned first frame bearing feed hole 27 and the aforementioned operating chamber 18 are linked via a throttle passage 42 which accommodates a small amount of leakage.

[0027] By having the configuration described above, the oil in the lubricating oil sump 22 can be lifted to the first frame bearing feed hole 27 , which is the highest position, and an oil can also be fed to the second frame bearing feed hole 25 and the orbital bearing feed hole 26 by the differential pressure of a discharge pressure and the aforementioned operating chamber 18 pressure. Thereafter, the lubrication of each bearing part is carried out by the viscosity pump operation of the volute slots 39, 40, 41, and the oil is recirculated to the lubricating oil sump 22.

[0028] The embodiment described above is a case wherein the atmosphere of the lubricating oil sump 22 was high pressure, and the following embodiment describes the case under low pressure.

[0029] Figure 8 shows the overall structure of a scroll compressor showing another embodiment of the present invention. Portions common to those of the first embodiment in Fig. 1 are given the same reference numbers and the descriptions thereof are omitted.

[0030] In the first fixed scroll 4 and the second fixed scroll 5, a sealing means 43 and 44 which comprise a seal ring and a ring groove are formed between them and the orbiting scroll 4 and seal of the discharge pressure. The discharge tube 10 is connected directly to the first frame discharge passage two 2a, and air tightness is maintained although this is not illustrated. A wall surface in the tightly sealed container 1 center section is penetrated, a suction pipe 9 is arranged, a suction hole 45 is established in the second frame three, and this leads to suction holes 46 and 47 formed in the first fixed scroll 4 and the second fixed scroll 5. Therefore, when the orbiting scroll 6 rotates by rotation of the crank shaft 8, the fluid to be compressed is sucked from the suction pipe 9, flows into the suction hole 45 and the suction holes 46 and 47, is compressed by the compression space 16 and 17, and after it reaches a predetermined pressure (discharge pressure), it is discharged out of the tightly sealed container 1 through the discharge tube 10 from the discharge passages 6g and 6i, the discharge through-hole 6h, the through hole 4c, and the discharge passage 2c. As stated above, having a configuration which directly continues the discharge tube to the discharge passage 2c allows the pressure atmosphere in the tightly sealed

container 1 to be made low pressure (suction pressure) by establishing the seal means 43 and 44 between the fixed scrolls and the orbiting scroll.

[0031] Below, the lubrication structure of this embodiment is explained.

[0032] In the aforementioned feed pipe 8f in the lower end of the aforementioned crank shaft 8, a first oil supply passage 23 which links to the lubricating oil sump 22 under a high-pressure atmosphere in the base of the aforementioned tightly sealed container 1 is formed, and the second oil supply passage 24 formed eccentrically to the axial center of the first oil supply passage 23 and linked to the first oil supply passage 23 and is extended to the upper supporting shaft 8c which is an upper support shaft of the crank shaft 8. A bearing feed hole formed radially outward such that it links to each bearing is installed in the aforementioned second oil supply passage 24. That is, the second frame bearing feed hole 25 is arranged in the first frame bearing 2a, the orbital bearing feed hole 26 is arranged in the orbital bearing 6b, and the first frame bearing feed hole 27 is arranged in the second frame bearing 3a, respectively. In the second oil supply passage 24, a sufficient passage area is secured so that pressure loss does not occur.

[0033] The oil in the lubricating oil sump 22 is sucked through the first oil supply passage 23 by centrifugal pump operation in the second oil supply passage 24, lubricating oil is supplied to the second frame bearing 3a via the second frame bearing feed hole 25, to the orbital bearing 6b via the orbital bearing feed hole 26, and to the first frame bearing 2a via the first more frame bearing feed hole 27, respectively. Here, a portion of the oil which lubricated the second frame bearing 3a passes through the bearing spaces to an electric motor chamber 28, and the remaining oil flows into the aforementioned electric motor chamber 28 via the oil return hole 29 formed in the second fixed scroll 5 and the upper part of the second frame 3. Part of the oil which lubricated the orbital bearing 6b flows downward through the bearing spaces and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining oil which lubricated the first fixed frame shaft carrier 2a flows upward toward the upper part to the aforementioned discharge passage 6g through the bearing spaces. Further, part of the oil which lubricated the first fixed frame bearing 2a flows downward through the bearing spaces to the and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining

oil which lubricated the first fixed frame shaft carrier 2a flows toward the upper part to the aforementioned discharge passage 6g through the bearing spaces to the aforementioned discharge passage 6g, and the remaining oil goes upward through the bearing spaces to the discharge space 1a. The oil discharged by the aforementioned discharge space 1a flows through the oil return path 30 which is provided in the peripheral part of the first frame and the second frame, is recirculated to the electric motor chamber 28, and together with the oil recirculated to the electric motor chamber 28 via the aforementioned hole 29, returns to the lubricating oil sump 22 under gravity.

[0034] Next, another embodiment of the present invention is

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described. Figure 9 shows the overall structure of a scroll compressor according to another embodiment of the present invention. Portions common to those of the embodiments in Fig. 6 and Fig. 8 are given the same reference numbers and the descriptions thereof are omitted.

[0035] Compared with the embodiments shown in Fig. 6 and Fig. 8, the lubrication structure is the same as shown in Fig. 6, and because this embodiment shows the case (as in Fig. 8) in which the atmosphere of the lubricating oil sump

22 is low pressure, an explanation of the structure and operation is omitted.

[0036] Next, another embodiment of the present invention is described. Figure 10 shows the overall structure of a scroll compressor according to another embodiment of the present invention are shown. Portions common to those of the embodiment in Fig. 8 are given the same reference numbers and the descriptions thereof are omitted.

[0037] The orbital bearing 6a is divided into two in the axial direction, and one end to the split surface is opened and an oil path 48 which opens in the other end of the concave part 6e formed in the axial center of the aforementioned orbiting scroll 6 which contains the Oldham's coupling 15 has been established. A trochoid pump is installed on the lower end of the crank shaft 8 as a forced pumping means, the oil supply passage 23 is extended to the upper supporting shaft which is an upper support shaft of the crank shaft 8 such that it links to an outlet hole 38 of the trochoid pump, and the bearing feed holes 25, 26, and 27 which are formed radially outward are installed such that they link to each bearing. A feed hole 49 which is formed radially outward such that it link to the aforementioned oil path 48 is installed.

[0038] By having the above configuration, the lubricating oil which is sucked out via the oil supply passage 23 and lifted by the trochoid pump lubricates each bearing via the bearing feed holes 25, 26, and 27, and the lubricating oil which flowed into the aforementioned feed hole 49 is supplied by the concave part 6e formed in the axial center of the aforementioned orbiting scroll 6 which contains the Oldham's coupling 15 via the oil path 48, the Oldham's coupling 15 is lubricated, and the oil returns to an inlet side.

[0039] Figure 11 shows the overall structure of a scroll compressor according to another embodiment of the present invention.

[0040] In the first fixed scroll 4 and the second fixed scroll 5, a seal means 43 and 44 which comprise a seal ring and a ring groove between them and the orbiting scroll 4 are installed and an O ring 50 is installed on the first frame 2 and the tightly sealed container 1, and these seal the discharge pressure and a discharge space 52 is formed. In the first frame 2, a section wall 51 which separates the upper supporting shaft 8c end of the crank shaft 8 and the discharge space 52 is formed, and although not illustrated, the air tightness in the section wall 51 is maintained. The discharge tube 10 is connected to the upper part of the

tightly sealed container 1 in the section wall 51. In the center of the tightly sealed container 1, the wall surface is penetrated by the suction pipe 9, a suction hole 45 is arranged in the second frame 3, and this leads to suction holes 46 and 47 formed in the first fixed scroll 4 and the second fixed scroll 5. In the first frame 2, a surface wall chamber 53 which is formed by the aforementioned section wall 51 and the low pressure side are connected by a communicating path 54.

[0041] Accordingly, when the orbiting scroll 6 is orbited by the rotation of the crank shaft 8, the fluid to be compressed is sucked from the suction pipe 9 and flows into the suction hole 45 and the suction inlets 46 and 47, is compressed by the compression spaces 16 and 17, and after reaching a predetermined pressure (discharge pressure), it is discharged into the discharge space 53 from the discharge passages 6g and 6i, the discharge through-hole 6h, the through hole 4c, and the discharge passage 2c, and is discharged out of the tightly sealed container 1 through the discharge tube 10. As explained above, the pressure atmosphere of the lubricating oil sump 22 can be made low pressure by having a configuration wherein the seal means 43 and 44 are arranged between the fixed scrolls and the orbiting scroll, the O ring 50 is arranged in the first

frame 2 and the tightly sealed container 1, and further, the section wall 51 which separates the upper supporting shaft 8c end of the crank shaft 8 and the discharge space 53 is provided.

[0042] Next, the lubrication structure of this embodiment is the same as that in the embodiment shown in Fig. 8, so the explanation is abbreviated here.

[0043] The oil in the lubricating oil sump 22 is sucked through the first oil supply passage 23 and the second oil supply passage 24, lubricating oil is supplied to the second frame bearing 3a via the second frame bearing feed hole 25, to the orbital bearing 6b via the orbital bearing feed hole 26, and to the first frame bearing 2a via the first more frame bearing feed hole 27, respectively. Here, a portion of the oil which lubricated the second frame bearing 3a passes downward through the bearing spaces to an electric motor chamber 28, and the remaining oil flows upward into the aforementioned electric motor chamber 28 via the oil return hole 29 formed in the second fixed scroll 5 and the upper part of the second frame 3. Further, part of the oil which lubricated the orbital bearing 6b flows downward through the bearing spaces and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining oil is

recirculated to the electric motor chamber 28 via the surface wall chamber 54, the communicating path 54 and the suction hole 45 together with the oil which lubricated the first fixed frame shaft carrier 2a, and together with the oil recirculated to the electric motor chamber 28 via the aforementioned return hole 29, returns to the lubricating oil sump 22 under gravity.

[0044] Next, Fig. 12 and Fig. 13 show the overall structure of a scroll compressor according to another embodiment of the present invention. Portions common to those of the embodiment in Fig. 9 and Fig. 10 are given the same reference numbers and the descriptions thereof are omitted.

[0045] The feature of this embodiment is that Fig. 12 and Fig. 9 and also Fig. 13 and Fig. 10 have the same lubrication structure. They differ in that the atmosphere of the lubricating oil sump 22 is under low pressure. Note that the configuration wherein atmosphere of the lubricating oil sump 22 is under low pressure is the same as that in Fig. 11 explained above, so an explanation of the structure and operation is omitted here.

[0046] Figure 14 shows the overall structure of a scroll

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compressor according to another embodiment of the present invention.

[0047] This shows the case where the crank shaft 8 is fixed by the upper support shaft of the orbital bearing 6b and there is no upper supporting shaft 8c compared with the aforementioned embodiment. An oil sump chamber 55 is formed in the upper support shaft side of the aforementioned eccentric shaft 8a of the first fixed scroll 4, and the oil sump room 55 and the low-pressure side are connected by a communicating path 56.

[0048] In the first fixed scroll 4 and the second fixed scroll 5, a seal means 43 and 44 which comprise a seal ring and a ring groove between them and the orbiting scroll 4 are installed and an O ring 50 is installed on the first frame 2 and the tightly sealed container 1, and these seal the discharge pressure and a discharge space 52 is formed. The discharge tube 10 is connected to the first frame 2, and in the center of the tightly sealed container 1, the wall surface is penetrated by the suction pipe 9, a suction hole 45 is arranged in the second frame 3, and this leads to suction holes 46 and 47 formed in the first fixed scroll 4 and the second fixed scroll 5.

[0049] Accordingly, when the orbiting scroll 6 is orbited by the rotation of the crank shaft 8, the fluid to be compressed is sucked from the suction pipe 9 and flows into the suction hole 45 and the suction inlets 46 and 47, is

compressed by the compression spaces 16 and 17, and after reaching a predetermined pressure (discharge pressure), it is discharged into the discharge space 53 from the discharge passages 6g and 6i, the discharge through-hole 6h, the through hole 4c, and the discharge passage 2c, and is discharged out of the tightly sealed container 1 through the discharge tube 10. As explained above, the pressure atmosphere of the lubricating oil sump 22 can be made low pressure by having a configuration wherein the seal means 43 and 44 are arranged between the fixed scrolls and the orbiting scroll, the O ring 50 is arranged in the first frame 2 and the tightly sealed container 1, and further, the upper supporting shaft 8c is omitted.

[0050] Next, the lubrication structure of this embodiment is the same as that in the embodiment shown in Fig. 8, except that there is no first frame bearing oil feed hole 27, so the explanation is abbreviated here. As a result of the configuration above, the lubricating oil which is sucked out via the oil supply passage 23 and lifted by the trochoid pump lubricates the second frame bearing 3a and the orbital bearing 6b via the bearing feed holes 25 and 26. Here, a portion of the oil which lubricated the second frame bearing 3a passes downward through the bearing spaces to an electric motor chamber 28, and the remaining oil

flows upward into the aforementioned electric motor chamber 28 via the oil return hole 29 formed in the second fixed scroll 5 and the second frame 3. Further, part of the oil which lubricated the orbital bearing 6b flows downward through the bearing spaces and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining oil is recirculated to the electric motor chamber 28 via the suction hole 45 after temporary holding in an oil holding chamber 55, and together with the oil recirculated to the electric motor chamber 28 via the aforementioned return hole 29, returns to the lubricating oil sump 22 under gravity.

[0051] Next, another embodiment of the present invention are described. Figure 15 shows the overall structure of a scroll compressor according to another embodiment of the present invention. Portions common to those of the embodiment in Fig. 1 are given the same reference numbers and the descriptions thereof are omitted.

[0052] A feature of the present invention is that the axial direction of the aforementioned crank shaft 8 is horizontally arranged compared with the embodiment shown in Fig. 1. That is, it shows a side laying type of scroll compressor of type. The scroll compressor shown in Fig. 15 comprises a tightly sealed container 1 of cylindrical shape

with the top and bottom ends sealed and its axis being substantially horizontal to the ground, a first frame 2 and a second frame 3 fixed in a left portion of the tightly sealed container 1 with their axes aligned with that of the tightly sealed container 1, a first fixed scroll 4 and second fixed scroll 5 fitted inside the first frame 2 and the second frame 3 with their axes aligned with those of the first frame and the second frame, each fixed scroll having a volute wrap so that the left and right wraps are opposite to each other, an orbiting scroll 6 having wraps opposing and rotatably mounted between the fixed scrolls 4, 5, an orbiting scroll driving motor, composed of a stator 7a and a rotor 7b, provided below the second frame 3 with its axis aligned with those of the first and second fixed scrolls 4, 5, a crank shaft 8 coupled with the rotor 7b and rotated by the rotor 7b such that the orbiting scroll 6 can be rotated by the crank shaft 8 through a swing bearing 6b, a suction pipe 9 provided through the side wall of the tightly sealed container 1 for supplying a space with a gas to be compressed, the space formed by the wrap of the first fixed scroll 4 and the wrap of the orbiting scroll 6, and a discharge pipe 10 provided through the side wall of the tightly sealed container 1.

[0053] The crank shaft 8 is constituted of a part 8d coupled with the rotor 7b, a lower supporting shaft portion 8b extending upwardly from the top of the part 8d and held by a second frame bearing 3a in the center of the second frame 3, an eccentric shaft portion 8a extending upwardly from the top of the lower supporting shaft portion 8b and fitted into the swing bearing 6b, an upper supporting shaft portion 8c extending upwardly from the top of the eccentric shaft portion 8a and held by a first frame bearing 2a fixed at the center of the first frame 2, a lower-end supporting shaft portion 8e extending downwardly from the bottom of the part 8d and held by an auxiliary bearing 12 fixed in an auxiliary frame 11 fixed on the side wall of the tightly sealed container 1, and an oil pump 8f opening into the base of the tightly sealed container 1. The crank shaft 8 further includes a lower balance weight 13 and an upper balance weight 14 mounted around the lower supporting shaft portion 8b and the upper supporting shaft portion 8c, respectively, so that centrifugal force of the orbiting scroll 6 and the moment by the centrifugal force are canceled, thereby preventing vibrations. It should be noted that the second frame bearing 3a is provided with a collar for supporting the total weight of the crank shaft 8 and

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the rotor 7b.

[0054] In the compressor with the aforementioned composition, when the orbiting scroll 6 rotates eccentrically (orbits) by the rotation of the crank shaft 8, the fluid to be compressed is sucked in from the suction pipe 9 and is compressed by the compression spaces 16, 17, and after a predetermined pressure (discharge pressure) is reached and it is discharged by the discharge space 1a of the upper part of the aforementioned tightly sealed container 1 from the discharge passages 6g, 6i, the discharge hole 6h, the through hole 4c, and the discharge passage 2c, it passes through a passage (not illustrated) formed between the tightly sealed container 1 and the first frame 2 and second frame 3, a passage (not illustrated) formed between the tightly sealed container 1 and the stator 7a, and a passage resistance part 60 which id formed in the auxiliary frame 11, and is discharged out of the tightly sealed container 1 through the discharge tube 10. Here 61 is a hermetic terminal fixed to the tightly sealed container 1 to supply electricity to the aforementioned stator 7a.

[0055] Next, the lubrication structure of this embodiment is explained.

[0056] The oil supply passage 23 which links to the aforementioned first feed pipe 58 provided in the right end section of the crank shaft 8 is formed in the central part of the aforementioned crank shaft 8. It is extended to the first supporting shaft 8c that is a left edge part of the crank shaft 8. A bearing feed hole formed radially outward such that it is linked to each bearing is arranged in the aforementioned oil supply passage 23. That is, the second frame bearing feed hole 25 is installed in the second frame bearing 3a, the orbital bearing feed hole 26 is installed in the orbital bearing 6b, and the first frame bearing feed hole 27 is installed in the first frame bearing 2a, respectively. In the oil supply passage 23, sufficient passage area is secured so that pressure loss will not occur.

[0057] Regarding the oil level in the lubricating oil sump 22 formed of the aforementioned auxiliary frame 11 and the side part of the aforementioned tightly sealed container 1, when the compressor is operated and the fluid to be compressed passes the passage resistance part 60 formed in the auxiliary frame 11, a pressure loss occurs, the oil level is pushed up by a pressure differential before and after the passage resistance part 60, and the oil level at operation is secured. When the compressor has stopped,

since there is no pressure differential before and after the passage resistance part 60, the oil level falls.

[0058] As a result of the configuration above, the oil in the lubricating oil sump 22 is sucked through the first oil supply passage 23 by centrifugal pump operation in the first feed pipe 58, lubricating oil is supplied to the second frame bearing 3a via the second frame bearing feed hole 25, to the orbital bearing 6b via the orbital bearing feed hole 26, and to the first frame bearing 2a via the first more frame bearing feed hole 27, respectively. Here, a portion of the oil which lubricated the second frame bearing 3a passes rightward through the bearing spaces to an electric motor chamber 28, and the remaining oil flows leftward into the aforementioned electric motor chamber 28 via the oil return hole 29 formed in the second fixed scroll 5 and the upper part of the second frame 3. Further, part of the oil which lubricated the orbital bearing 6b flows rightward through the bearing spaces and returns to aforementioned electric motor chamber 28 via the aforementioned oil return hole 29, and the remaining oil which lubricated the first fixed frame shaft carrier 2a flows leftward through the bearing spaces. Further, part of the oil which lubricated the first fixed frame bearing 2a flows rightward through the bearing spaces to the discharge

passage 6g, and the remaining oil flows leftward through the bearing spaces to the discharge space 1a. The oil discharged by the aforementioned discharge space 1a naturally falls to the bottom of the tightly sealed container 1 through the oil return path 30 which is provided in the peripheral part of the first frame and the second frame, and together with the oil recirculated to the electric motor chamber 28 via the aforementioned oil return hole, returns to the lubricating oil sump 22.

[0059] Next, Fig. 16 shows the overall structure of a scroll compressor according to another embodiment of the present invention are shown. Portions common to those of the embodiment in Fig. 15 are given the same reference numbers and the descriptions thereof are omitted.

[0060] A feature of this embodiment is a forced pumping means 62 installed at the right end of the second supporting shaft 8e of the crank shaft 8 as a lubrication structure compared with Fig. 12. Here, the forced pumping means 62 is a trochoid pump, etc., as mentioned above. Since this embodiment is the same as the embodiment shown in Fig. 15, except for the feed means, an explanation of structure and operation is omitted.

[0061]

[Effect of the Invention] According to the present invention, whether a lubricating oil sump has a high-pressure or a low-pressure atmosphere, a configuration wherein a second oil supply passage formed eccentrically such that it is be linked to a oil supply passage which links to the lubricating oil sump is provided and bearing oil supply holes are formed radially outward such that they link to the second oil supply passage or a configuration wherein a forced pumping means is provided in the aforementioned lubricating oil sump end of the aforementioned oil feed passage or volute grooves which link to bearing oil feed holes formed radially outward are provided provides certain lubrication of the various parts of each bearing or sliding part, and thereby, the reliability of a compressor is improved.

[0062] When a lubricating oil sump has a low-pressure atmosphere, lubrication of the various parts of each bearing or sliding part can be further performed certainly with a configuration wherein a seal mechanism is provided between the aforementioned orbiting scroll and the aforementioned fixed scrolls and an oil return passage is opened for free passage to the aforementioned lubricating

oil sump, and thereby, the reliability of a compressor is further improved.

[Brief Description of the Drawings]

[Figure 1] This is a figure showing the overall structure of a scroll compressor according to an embodiment of the present invention.

[Figure 2] This is a perspective view of the Oldham's coupling of an embodiment of the present invention.

[Figure 3] This is a sectional view of an orbiting scroll according to an embodiment of the present invention.

[Figure 4] This is a sectional view of a second fixed scroll according to the present invention.

[Figure 5] This is a sectional view of a first fixed scroll of an embodiment of the present invention.

[Figure 6] This is a figure showing the overall structure

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of a scroll compressor according to another embodiment of the present invention.

[Figure 7] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 8] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 9] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 10] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 11] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 12] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 13] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 14] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

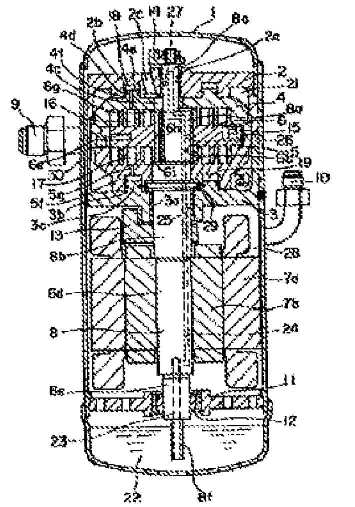
[Figure 15] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

[Figure 16] This is a figure showing the overall structure of a scroll compressor according to another embodiment of the present invention.

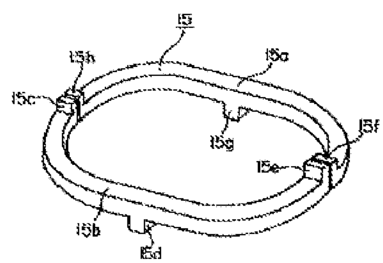
[Legend]

1 ... Tightly sealed container, 2 ... First frame, 3 ... Second frame, 4 ... First fixed scroll, 5 ... Second fixed scroll, 6 ... Orbiting scroll, 8 ... Crank shaft, 9 ... Suction pipe, 10 ... Discharge pipe, 15 ... Oldham's coupling, 16, 17 ... Compression space, 18, 19, ... Operating chamber, 22 ... Lubricating oil sump, 23 ... First oil supply passage, 24 ... First oil supply passage, 25, Second frame bearing feed hole, 26 ... Orbital bearing feed hole, 27 ... First frame bearing feed hole, 28 ... Electric motor chamber, 29 ... Oil return hole, 30 ... Oil return passage, 31 ... Pump shaft, 32, ... Inner rotor, 33 ... Outer rotor, 34 ... Casing, 35 ... Top side plate, 36 ... Bottom side plate, 37 ... Suction hole, 38 ... Outlet hole, 39, 40, 41 ... Volute slot, 42 ... Throttle passage, 43, 44 ... Seal means, 45 ... Suction hole, 46, 47 ... Inlet, 48 Oil feed passage, 49 ... Oil feed hole, 50 ... O-ring, 51 ... Communicating passage, 51, ... Surface wall, 52 ... Discharge space, 53 ... Surface wall chamber, 54 ... Communicating passage, 55 ... Oil sump chamber, 56 ... Communicating passage, 57 ... Auxiliary bearing housing, 58 ... First feed pipe, 59 ... Second feed pipe, 60 ... Passage resistance part, 61 ... Hermetic terminal, 62 ... Forced pumping means

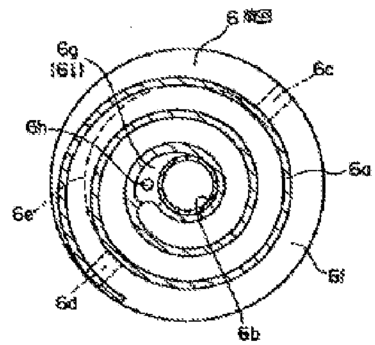
[Fig. 1]



[Fig. 2]



[Fig. 3]



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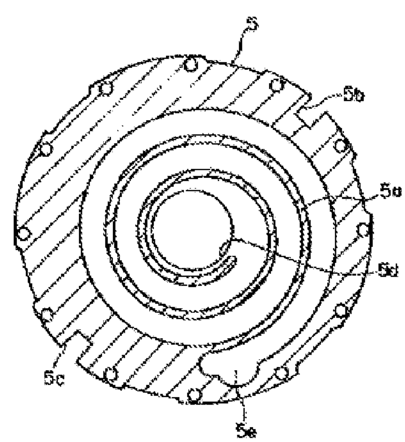
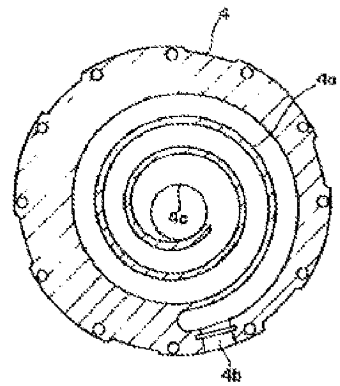
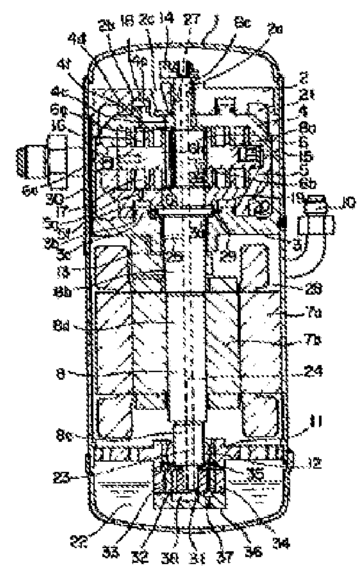
[Fig. 4]



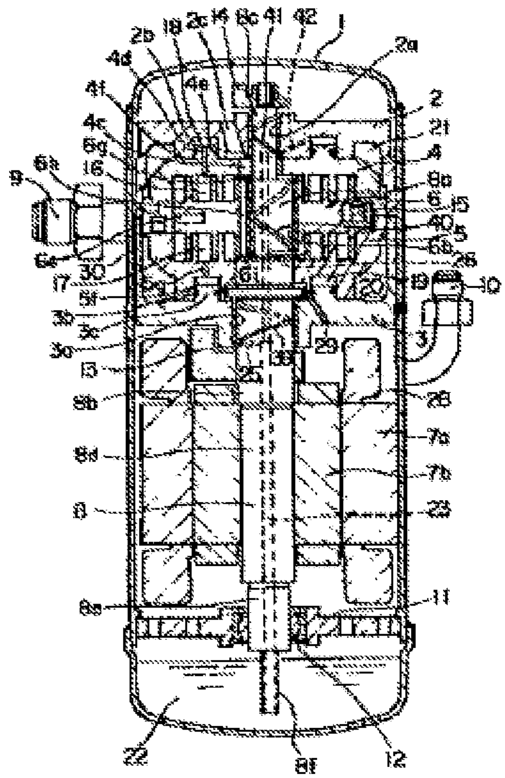
[Fig. 5]



[Fig. 6]



[Fig. 7]



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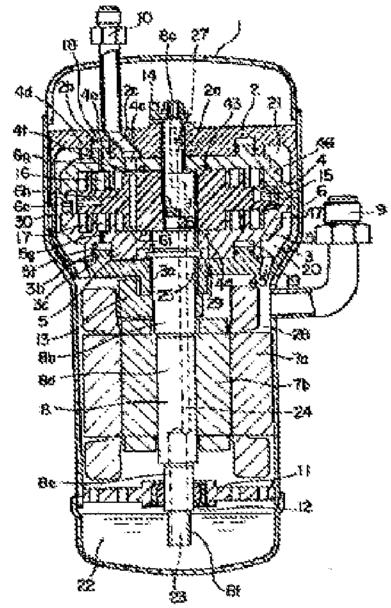
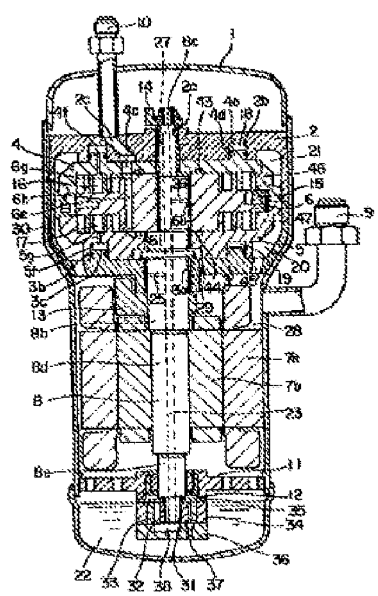
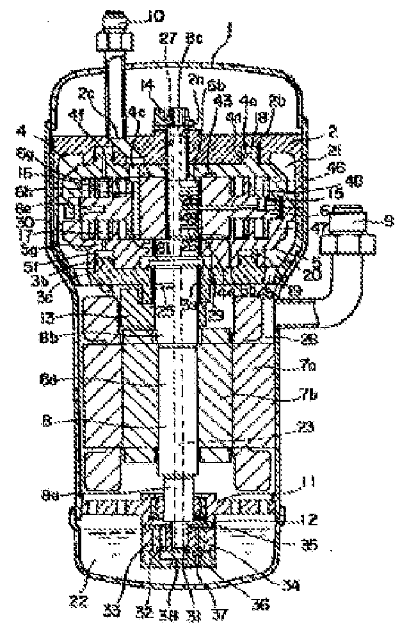
[Fig. 8]



[Fig. 9]



[Fig. 10]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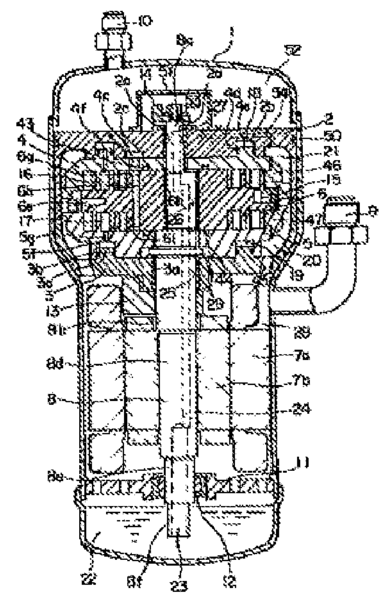
[Fig. 11]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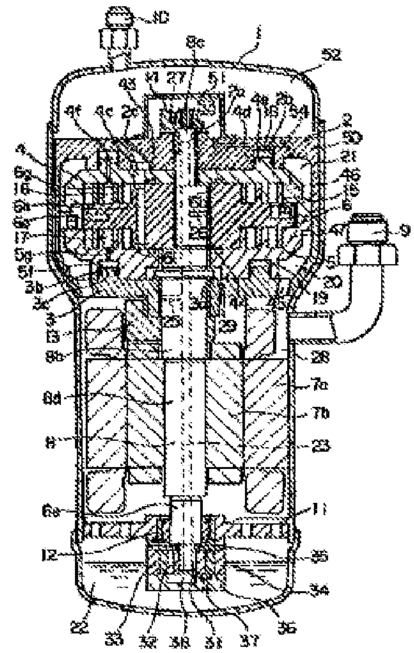
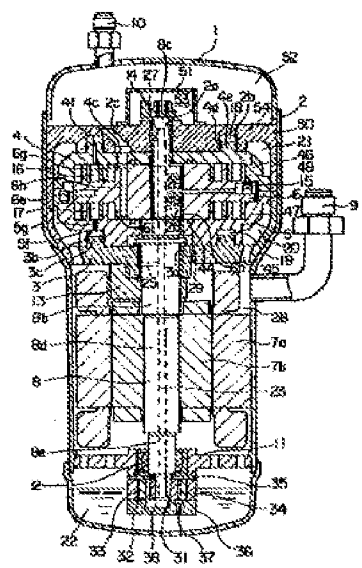
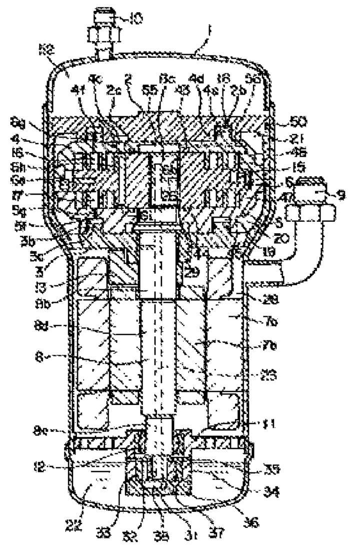
[Fig. 12]



[Fig. 13]



[Fig. 14]



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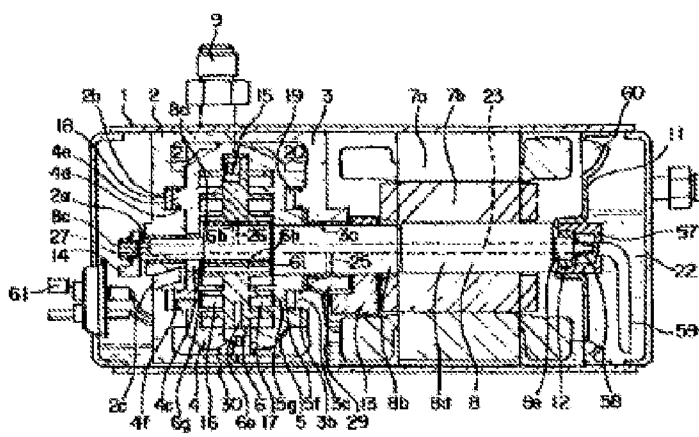
[Fig. 15]



[Fig. 16]